CLAIMS

What is claimed is:

1. A light source comprising at least one light emitting diode (LED) assembly, said LED assembly including a base substrate, said base substrate including base solder or stud bumps, a submount substrate mounted on the base substrate, said submount substrate including submount solder or stud bumps, and an LED semiconductor chip mounted on the submount substrate and in electrical contact with the submount solder or stud bumps, said LED semiconductor chip being electrically coupled to the base substrate through electrical vias extending through the submount substrate that are in electrical contact with the substrate solder or stud bumps and the submount solder or stud bumps.

2. The light source according to claim 1 further comprising a molded lens formed over the LED assembly.

3. The light source according to claim 2 wherein the molded lens is an injection molded lens.

4. The light source according to claim 2 wherein the molded lens is in contact with the LED assembly so that there is not an air gap between the lens and the LED semiconductor chip.

5. The light source according to claim 4 wherein the lens is molded to the base substrate and completely encapsulates the submount substrate and the LED semiconductor chip.

6. The light source according to claim 2 further comprising a silicon gel formed between the LED assembly and the molded lens.

7. The light source according to claim 2 wherein the at least one LED assembly is a plurality of LED assemblies each including a separate molded lens.

8. The light source according to claim 7 wherein all of the molded lenses are optically coupled to a single optical structure.

9. The light source according to claim 8 wherein the optical structure is a prism that directs the light from all of the LED assemblies in a common direction.

10. The light source according to claim 8 wherein the optical structure includes a phosphor material for converting light from the LED semiconductor chip to white light.

11. The light source according to claim 8 wherein the optical structure is made of an optical plastic and is glued to the lenses by an optical glue.

12. The light source according to claim 2 wherein the lens is an elongated lens including a head portion positioned directly over the LED assembly and a body portion extending from the head portion.

13. The light source according to claim 12 wherein the lens includes a shoulder separating the head portion and the body portion.

14. The light source according to claim 12 further comprising a reflective foil formed on an outer surface of the lens.

15. The light source according to claim 14 wherein the reflective foil is formed to the lens when the lens is molded.

16. The light source according to claim 2 wherein the lens directs part of the light received from the LED assembly back to the LED assembly to be reflected therefrom as a virtual image.

17. The light source according to claim 16 wherein the light directed back to the LED assembly is reflected off of a surface of the submount substrate.

18. The light source according to claim 17 wherein the surface of the submount substrate includes a metalized reflective layer.

19. The light source according to claim 2 wherein the molded lens includes a phosphor material for converting light from the LED semiconductor chip to white light.

20. The light source according to claim 2 wherein the molded lens is a primary optic dome formed over the LED assembly.

21. The light source according to claim 1 wherein the at least one LED semiconductor assembly is a plurality of LED assemblies providing a predetermined light pattern, wherein each LED assembly in the plurality of LED assemblies provides a portion of the intensity of the entire light pattern.

22. The light source according to claim 1 wherein an electrode path printed on the semiconductor chip defines a light beam cutoff to define a shape of the beam emitted from the LED assembly.

23. The light source according to claim 1 wherein the at least one LED assembly further includes a phosphor layer deposited over the LED semiconductor chip, said LED semiconductor chip emitting blue light and said phosphor layer converting the blue light to white light.

24. The light source according to claim 23 wherein a light beam cutoff pattern of the LED assembly is printed into the phosphor layer.

25. The light source according to claim 1 wherein the LED semiconductor chip is a rectangular chip.

26. The light source according to claim 25 wherein the LED semiconductor chip is 1 mm x 6 mm.

27. The light source according to claim 25 wherein the LED semiconductor chip is a 1 mm x 2 mm.

28. The light source according to the claim 1 further comprising a heat sink mounted to the base substrate.

29. The light source according to claim 28 wherein the heat sink includes a plurality of spaced apart fins.

30. The light source according to claim 28 wherein the heat sink is selected from the group consisting of thermal pipes and thermal coolers.

31. The light source according to claim 1 wherein the light source is a vehicle light source.

32. The light source according to claim 31 wherein the light source is a vehicle headlight.

33. The light source according to claim 32 wherein the LED assembly is sealed from the environment.

34. The light source according to claim 32 further comprising a carrier, said base substrate being mounted to the carrier.

35. The light source according to claim 33 further comprising a headlight housing, said carrier being pivotally mounted to the headlight housing by an adjuster and a pivot element so as to direct the headlight in two-axis of freedom.

36. The light source according to claim 35 further comprising a flexible boot, said flexible boot being mounted to the carrier and the headlight housing so as to allow the carrier to be rotated and to maintain the seal integrity.

37. The light source according to claim 36 wherein the flexible boot is co-molded to the headlight housing and the carrier.

38. The light source according to claim 36 wherein the flexible boot is co-molded to the headlight housing and a mechanical clip, and wherein the mechanical clip is clipped to the carrier.

39. The light source according to claim 36 wherein the flexible boot is a rubber boot.

40. A light source comprising at least one light emitting diode (LED) assembly, the LED assembly including an LED semiconductor chip and a substrate, said semiconductor chip being electrically coupled to the substrate, said LED assembly further including a molded primary optic formed over the LED assembly in contact with the substrate so that there is not an air gap between the primary optic and the LED semiconductor chip.

41. The light source according to claim 40 wherein the primary optic is an injection molded optic.

42. The light source according to claim 41 wherein the primary optic is an injection molded dome on the substrate.

43. The light source according to claim 40 further comprising a silicon gel formed between the primary optic and the semiconductor chip.

44. The light source according to claim 40 wherein the primary optic is molded to the substrate and completely encapsulates the LED assembly.

45. The light source according to claim 40 wherein the at least one LED assembly is a plurality of LED assemblies each including a separate molded primary optic.

46. The light source according to claim 45 wherein all of the molded primary optics are optically coupled to a single optical structure.

47. The light source according to claim 46 wherein the optical structure is a prism that directs the light from all of the LED assemblies in a common direction.

48. The light source according to claim 46 wherein the optical structure includes a phosphor material for converting light from the LED semiconductor chip to white light.

49. The light source according to claim 46 wherein the optical structure is made of an optical plastic and is glued to the lenses by an optical glue.

50 The light source according to claim 40 wherein the primary optic is an elongated lens including a head portion positioned directly over the LED assembly and a body portion extending from the head portion.

51. The light source according to claim 50 wherein the primary optic includes a shoulder separating the head portion and the body portion.

52. The light source according to claim 40 wherein the primary optic includes a reflective foil on its outer surface.

53. The light source according to claim 52 wherein the reflective foil is formed to the primary optic when the primary optic is molded.

54. The light source according to claim 40 wherein the primary optic directs part of the light received from the LED assembly back to the LED assembly to be reflected therefrom as a virtual image.

55. The light source according to claim 54 wherein the light directed back to the LED assembly is reflected off of a surface of the substrate.

56. The light source according to claim 55 wherein the surface of the substrate includes a metalized reflective layer.

57. The light source according to claim 40 wherein the primary optic includes a phosphor material for converting light from the LED semiconductor chip to white light.

58. The light source according to claim 40 wherein the at least one LED assembly further includes a phosphor layer deposited over the LED semiconductor chip, said LED semiconductor chip emitting blue light and said phosphor layer converting the blue light to white light.

59. The light source according to claim 58 wherein a light beam cutoff pattern of the LED assembly is printed into the phosphor layer.

60. The light source according to claim 58 wherein the at least one LED assembly is a plurality of LED assemblies providing a predetermined

light pattern, wherein each LED assembly in the plurality of LED assemblies provides a portion of the intensity of the entire light pattern.

61. The light source according to claim 40 wherein an electrode path printed on the semiconductor chip defines a beam cutoff to define a shape of the beam emitted from the LED assembly.

62. The light source according to claim 40 wherein the LED semiconductor chip is a rectangular chip.

63. The light source according to claim 62 wherein the LED semiconductor chip is 1 mm x 6 mm.

64. The light source according to claim 62 wherein the LED semiconductor chip is 1 mm x 2 mm.

65. The light source according to the claim 40 further comprising a heat sink mounted to the substrate.

66. The light source according to claim 65 wherein the heat sink includes a plurality of spaced apart fins.

67. The light source according to claim 65 wherein the heat sink is selected from the group consisting of thermal pipes and thermal coolers.

68. The light source according to claim 40 wherein the light source is a vehicle light source.

69. The light source according to claim 68 wherein the light source is a vehicle headlight.

70. The light source according to claim 69 wherein the LED assembly is sealed from the environment.

71. The light source according to claim 70 further comprising a carrier, said base substrate being mounted to the carrier.

72. The light source according to claim 71 further comprising a headlight housing, said carrier being pivotally mounted to the headlight housing by an adjuster and a pivot element so as to direct the headlight in two-axis of freedom.

73. The light source according to claim 72 further comprising a flexible boot, said flexible boot being mounted to the carrier and the headlight housing so as to allow the carrier to be rotated and to maintain the seal integrity.

74. The light source according to claim 73 wherein the flexible boot is co-molded to the headlight housing and the carrier.

75. The light source according to claim 73 wherein the flexible boot is co-molded to the headlight housing and a mechanical clip, and wherein the mechanical clip is clipped to the carrier.

76. The light source according to claim 73 wherein the flexible boot is a rubber boot.

77. A vehicle headlight comprising at least one headlight unit, said at least one headlight unit including an optical structure, said at least one headlight unit further including a plurality of spaced apart primary optic lenses optically coupled to a front face of the optical structure, said at least one headlight unit further including a plurality of light emitting diode (LED) assemblies, where a single LED assembly is provided for each lens, wherein each LED assembly emits a beam of light that is focused and directed by the elongated lens and is collected and directed by the optical structure to be emitted from the front face of the optical structure as a single beam of light, wherein each LED assembly in the plurality of LED assemblies provides a portion of the intensity of the entire light pattern.

78. The headlight according to claim 77 wherein each lens is an elongated lens including a head portion and a body portion.

79. The headlight according to claim 78 wherein each elongated lens is molded to the LED assembly so that the head portion is positioned directly over the LED assembly.

80. The headlight according to claim 78 wherein each elongated lens includes a shoulder separating the head portion and the body portion.

81. The headlight according to claim 77 wherein each lens is in contact with the LED assembly so that there is not an air gap between the lens and the LED assembly.

82. The headlight according to claim 77 wherein each lens is an injection molded lens.

83. The headlight according to claim 77 wherein each lens includes a reflective foil formed on its outer surface.

84. The headlight according to claim 83 wherein the reflective foil is formed to the lens when the lens is molded.

85. The headlight according to claim 77 wherein the primary optic lens is an injection molded dome.

86. The headlight according to claim 77 wherein each lens includes a phosphor material for converting light from the LED assembly to white light.

87. The headlight according to claim 77 wherein the optical structure includes a phosphor material for converting light from the LED assembly to white light.

88. The headlight according to claim 77 wherein each lens directs part of the light received from the LED assembly back to the LED assembly to be reflected therefrom as a virtual image.

89. The headlight according to claim 77 wherein the plurality of LED assemblies and lenses is six lenses and six LED assemblies.

90. The headlight according to claim 77 wherein each LED assembly includes an LED semiconductor chip that emits blue light and a phosphor layer that converts the blue light to white light.

91. The headlight according to claim 90 wherein a light beam cutoff pattern of the LED assembly is printed into the phosphor layer.

92. The headlight according to claim 77 wherein each LED assembly includes an LED semiconductor chip that is a rectangular chip.

93. The headlight according to claim 92 wherein the LED semiconductor chip is 1 mm x 6 mm.

94. The headlight according to claim 92 wherein the LED semiconductor chip is 1 mm x 2 mm.

95. The headlight according to claim 77 wherein the plurality of LED assemblies is mounted to a common carrier.

96. The headlight according to claim 95 further comprising a headlight housing, said carrier being pivotally mounted to the headlight housing by an adjuster and a pivot element to direct the headlight in two degrees of freedom.

97. The headlight according to claim 96 further comprising a flexible boot, said flexible boot being mounted to the carrier and the headlight housing so as to allow the carrier to be rotated and maintain a headlight seal integrity.

98. The headlight according to claim 97 wherein the flexible boot is co-molded to the headlight housing and the carrier.

99. The headlight according to claim 97 wherein the flexible boot is co-molded to the headlight housing and a mechanical clip, and wherein the mechanical clip is clipped to the carrier.

100. The headlight according to claim 97 wherein the flexible boot is a rubber boot.

101. The headlight according to claim 95 wherein the carrier includes a heat sink.

102. The headlight according to claim 101 wherein the heat sink includes a plurality of spaced apart fins.

103. The light source according to claim 101 wherein the heat sink is selected from the group consisting of thermal pipes and thermal coolers.

104. A vehicle headlight comprising at least one headlight unit, said at least one headlight unit including an optical prism and a plurality of spaced apart molded elongated lenses optically coupled to a front face of the prism, each elongated lens including a head portion and a body portion, said at least one headlight unit further including a plurality of light emitting diode (LED) assemblies, where a single LED assembly is provided for each lens, said LED assembly including a base substrate, said base substrate including base solder or stud bumps, a submount substrate mounted on the base substrate, said submount substrate including submount solder or stud bumps, and an LED semiconductor chip mounted on the submount substrate and in electrical contact with the submount solder or stud bumps, said LED semiconductor chip being electrically coupled to the base substrate through electrical vias extending through the submount substrate that are in electrical contact with the substrate solder or stud bumps and the submount solder or stud bumps, wherein each LED assembly emits a beam of light that is focused and directed by the elongated lens and is collected and directed by the prism to be emitted from the front face of the prism as a single beam of light.

105. The headlight according to claim 104 wherein each molded lens is an injection molded lens.

106. The headlight according to claim 104 wherein each molded lens is in contact with the LED assembly so that there is not an air gap between the lens and the LED semiconductor chip.

107. The headlight according to claim 104 wherein each elongated lens is molded to the base substrate and completely encapsulates the submount substrate and the LED assembly.

108. The headlight according to claim 104 wherein the head portion of each lens includes a reflective foil formed on its outer surface.

109. The headlight according to claim 108 wherein the reflective foil is formed to the outer surface of each lens when it is molded.

110. The headlight according to claim 104 wherein each lens includes a shoulder separating the head portion and the body portion.

111. The headlight according to claim 104 wherein each molded lens includes a phosphor material for converting light from the LED semiconductor chip to white light.

112. The headlight according to claim 104 wherein each lens directs part of the light received from the LED assembly back to the LED assembly to be reflected therefrom as a virtual image.

113. The headlight according to claim 112 wherein the light directed back to the LED assembly is reflected off of a surface of the submount substrate.

114. The headlight according to claim 113 wherein the surface of the submount substrate includes a metalized reflective layer.

115. The headlight according to claim 104 wherein the prism includes a phosphor material for converting light from the LED semiconductor chip to white light.

116. The headlight according to claim 104 wherein each LED assembly further includes a phosphor layer deposited over the LED semiconductor chip, said LED semiconductor chip emitting blue light and said phosphor layer converting the blue light to white light.

117. The headlight according to claim 104 wherein an electrode path printed on the LED semiconductor chip defines a beam cutoff to define a shape of the beam emitted from the LED assembly.

118. The headlight according to claim 104 wherein the LED semiconductor chip is a rectangular chip.

119. The headlight according to claim 118 wherein the LED semiconductor chip is 1 mm x 6 mm.

120. The headlight according to claim 118 wherein the LED semiconductor chip is 1 mm x 2 mm.

121. The headlight according to claim 104 wherein the plurality of LED assemblies provide a predetermined light pattern, and wherein each LED assembly in the plurality of LED assemblies provides a portion of the intensity of the entire light pattern.

122. The headlight according to claim 104 wherein all of the LED assemblies are mounted to a common carrier.

123. The headlight according to claim 122 further comprising a headlight housing, said carrier being pivotally mounted to the headlight housing by an adjuster and a pivot element to direct the headlight in two degrees of freedom.

124. The headlight according to claim 123 further comprising a flexible boot, said flexible boot being mounted to the carrier and the headlight housing so as to allow the carrier to be rotated and maintain a headlight seal integrity.

125. The headlight according to claim 124 wherein the flexible boot is co-molded to the headlight housing and the carrier.

126. The headlight according to claim 124 wherein the flexible boot is co-molded to the headlight housing and a mechanical clip, and the mechanical clip is clipped to the carrier.

127. The headlight according to claim 124 wherein the flexible boot is a rubber boot.

128. The headlight according to claim 122 wherein the carrier includes a heat sink.

129. The headlight according to claim 128 wherein the heat sink includes a plurality of spaced apart fins.

130. The headlight according to claim 128 wherein the heat sink is selected from the group consisting of thermal pipes and thermal coolers.

131. A method of making an LED lamp, said method comprising:

electrically coupling an LED to a substrate by a solder reflow process; and

depositing a phosphor layer over the LED after it is electrically coupled to the substrate.

132. The method according to claim 131 wherein the LED is a blue LED and the phosphor layer generates white light from the blue light.

133. The method according to claim 131 wherein the solder is selected from the group consisting of tin-lead, tin-copper and tin-silver.

134. The method according to claim 132 wherein the solder has a melting temperature above 200°C.

135. The method according to claim 131 wherein depositing the phosphor layer over the LED includes simultaneously depositing the phosphor layer over a plurality of LEDs using a stencil mask.